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ABSTRACT

Creativity can be considered a function of knowledge, imagination, and evaluation and usually programed instruction is thought to be detrimental to creative behavior since the material is highly structured and the responses are usually restricted. However, this need not be so, for one seed of creativity, student control, is inherent in programed instruction. To test the possibility of teaching creative behavior via programed instruction a program on problem solving was developed and experimentally evaluated. The experiment involved six schools and 62 subjects in each of three groups: control, program alone, and program instructor-presented. A battery of psychological tests involving various aspects of creativity was used as a pre- and posttest. The results of the experiment indicated that the program instructor-presented group scored significantly higher gains than the program alone group, which in turn was significantly higher than the control group. (WH)

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P R O G R A M M I N G C R E A T I V E B E H A V I O R

The following paper is presented in two parts:
First -- Program Development
Second - Research, Procedures, Results and Findings

PROGRAM DEVELOPMENT

INTRODUCTION

Creativity can be considered a function of knowledge, imagination and evaluation. Without knowledge, imagination cannot be creatively productive. With abundant knowledge, but without manipulation thereof, no worthwhile creativity would result. Imagination and knowledge, however, without the ability to evaluate, synthesize and develop ideas, will not result in effective creativity. Creative productivity is intimately related to knowledge, which is manipulated, evaluated and effectively developed into usable ideas.

Although both Miel (1961) and Zirbes (1959) have shown that teachers are very aware of the increasing need to encourage creative behavior, present educational systems still overlook the intentional enhancement of creative ability in students. There is much emphasis on creative teaching, but relatively less emphasis is placed on teaching for the development of creative behavior.

Williams (1963), summarizing a variety of investigations, states that approximately one-quarter to one-half of the total classroom time is spent telling students what to do. Another quarter was spent in providing information, much of which is administrative. Only five percent is devoted to reinforcement of students' responses. Reinforcement for creative responses is almost completely lacking. In addition, teachers allotted only about one and one-half percent of the classroom time to decision-making functions.

The importance of the planned development of creative behavior is becoming more and more apparent to leaders in professions. Irving Taylor (in P.Smith, 1959)

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reports that a committee of 17 leading psychologists placed creativity and its cultivation at the top of a list of areas deserving the highest research priority in the behavioral sciences.

Research on the development of creative behavior has been conducted on an increasing scale ever since the presidential address of J. P. Guilford (1950) to the American Psychological Association. He emphasized the "appalling neglect" of the study of creativity, indicating that of some 121,000 titles indexed in Psychological Abstracts from its beginning until 1950, only 186 were definitely related to that subject. A recent bibliography of writings on creativity and related problems (Razik, 1965) lists 4,176 items. Half of the entries are dated 1950 or later; half of that half appeared in 1960 or later. The field is rapidly expanding, and persons interested in creativity are now faced with difficulties in keeping abreast of developments.

At least six research projects discussed by the Research Conference on Creativity at the University of Utah indicated that creative ability can be measurably enhanced by planned cultivation (in C. W. Taylor, 1959.) More recent studies have further confirmed these earlier findings (Taylor, 1964a, 1964b; Taylor and Williams, 1966.)

Research findings consistently demonstrate that creative behavior can be significantly stimulated by deliberate treatment. This is a direct confirmation of the conviction expressed over ten years ago by Guilford: "Like most behavior, creative activity probably represents, to some extent, many learned skills. There may be limitations set on these skills by heredity; but I am convinced that through learning one can extend the skills within those limitations."

It can be seen that in the creativity research reported in the literature, five major types of questions are dealt with. They are:

(1) Is there a relationship between the degree of creative behavior of individuals and such measures as tests of cognitive functioning, personality tests, and other non-intellectual instruments?

(2) What are the effects on creative thinking of various factors postulated to be inhibiting to productive thinking -- such as pathological personality syndroms and experimentally induced anxiety?

(3) What is the relative problem-solving effectiveness of individuals versus groups?

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(4) To what extent can creative behavior be deliberately stimulated?

(5) What are the relationships among creativity, intelligence, and achievement?

The primary research conducted at the State University of New York at Buffalo before 1968 was concerned with pilot experimentation and the development of courses, programs and methods designed to stimulate creative behavior.

The linking of programmed instruction and creativity implies something of a paradox for the most distinctive virtues of the technique of programmed instruction appear in some respects inconsistent with the requirements of creativity. It is the attempt of this paper to show how this apparent paradox may be resolved -- to show not only how programmed instruction can avoid or minimize its potentially detrimental effects on creativity, but also how programmed instruction can itself be directly used as a powerful instrument for the strengthening of creativity.

Oddly enough, the potentially detrimental effects of programmed instruction on creativity stem directly from the basic pedagogical virtues of the method. Its very power and success as an instructional tool contain the seeds of its thread of creativity:

(1) For one thing, programmed instruction may lead to an undesirable uniformity in content and ways of thinking. This tends to result because of the high degree of pre-structuring of the material, and the closely guided control of the thought processes of the individual as he proceeds step by step through the material. All the other individuals taking the program march in the same precise steps. At the end of a successful program we can expect, therefore, to find all of the students having arrived at the <u>same</u> understanding of the <u>same</u> material through the same series of guided steps. Such uniformity precludes the diversity in thought processes which is essential to the promotion of creativity, both in the individual and in the group. The diversity of ways of thinking in the group is one of the crucial conditions favoring originality of thought in the individual. When all individuals around him think about problems in the same way, this tends to inhibit innovative thought in the individual.

(2) Moreover, the highly structured and controlled character of programmed instruction makes it less able to take optimal account of the distinctive ways

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in which the individual thinks. There are many equally appropriate cognitive paths to the same final understanding of the subject matter. These paths represent different cognitive styles in the thinking processes of individuals. To attain creative understanding, the individual needs to be encouraged to make the most of his own distinctive cognitive style, to proceed in the way most "natural" to him. This feature of programming can be mitigated, of course, by techniques of branching and the like, which permit various alternative routes t the final learning goal. But thus far in the field of programmed instruction, such flexible branching techniques have not been widely developed and used.

(3) The very characteristics of a good program that make for smooth, spoon-fed learning may militate against creative stimulation of the individual. Programmed learning may become too effortless, too much centered in the program and too little in the mental searching and striving of the individual. The focus of cognitive initiative is thus subtly shifted from the individual to the program; the aim is to tune the individual to the program, rather than the program to the individual. It remains whether effortless learning does in fact impair creativity. Yet there is every reason to suppose that it does so.

(4) The sheer efficiency and effectiveness of a good program which takes the individual in a "logical lock-step" through pre-determined cognitive paths may tend to instill in the individual a sense of deference to the authority of the program. There is too little opportunity for the thoughtful individual to question, dissent from, or even reject, the content of the program material. Creativity almost necessarily contains something of a repudiation of authority. Thus anything that is too effectively taught in an authoritative way may hamper the student's creativity. In short, there may be something of an intrinsic opposition between the goals of creativity and the goals of efficient learning.

(5) Finally, one of the essentials of creativity would appear to be the ability to tolerate ambiguity, complexity, and lack of closure, while progressing toward the solution of the problem. Yet a cardinal aim of the programmed instruction is to achieve the utmost of clarity, precision, and definiteness in each step in the cognitive task. Here too, then, an inherent virtue of programmed instruction may serve to inhibit creativity.

The blackest possible picture of the case has deliberately been drawn. In fact, all of these features of programmed instruction potentially detrimental

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to creativity can be mitigated in their effects by avoiding overly strong commitment to rigid forms of programming and by inventing new programming techniques that are positively adapted to the requirements of creativity training. The self-pacing, self-directing, and self-administering features of programmed instruction lend themselves directly to the requirements of creativity training, for these characteristics do place the focus of cognitive initiative in the individual, and they open the way for an optimal accomodation of the program to the distinctive cognitive style of the individual. To meet these requirements more fully, these particular characteristics of programming need to be emphasized and extended.

Greater freedom in the choice of materials and the choice of alternative paths open to the student can be provided through appropriate branching techniques. Better and more sensitive diagnosite tools need to be provided enabling evaluation of the progress of the individual through the materials and enabling selection of appropriate subsequent steps and paths. Far more flexible forms of feedback need to be created which can be optimally suited to the distinctive responses of the particular individual.

CREATIVE SKILLS AND ATTITUDES

The training of creativity in the individual necessitates both the strengthening of certain cognitive skills which are central to the creative process and the encouragement of certain attitudes and dispositions which favor the use of these skills.

One of the most central skills involved in all creative activity is the ability to generate many ideas, and ideas that are uncommon and original. It is not enough, of course, that the ideas be uncommon and original, they must also be effectively adaptive to the demands of the particular creative task -- whether it be solving a problem, inventing a new concept. Closely related, therefore, is the skill in evaluating ideas, testing their adequacy against the demands of the creative task, and rejecting or revising them as required.

Another essential for creativity is the capacity to formulate the creative problem in workable terms and to re-formulate it as required. The individual must be able to transform the common into the uncommon, and to see the familiar in the strange.

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In approaching materials, the creative individual must be sensitive to their subtle and implicit features, having the capacity to think intuitively, grasping essential attributes without necessarily being able to analyze them explicitly. Yet at other times he must also be able to analyze the materials, to detect inconsistencies, and to bring orderly structure out of the initial confusion.

In order to develop and utilize these creative skills to an optimal degree, the individual must possess certain special dispositions and attitudes, and creativity training must concern itself with the encouragement of those attitudes as well as with the strengthening of creative skills. Foremost among such attitudes is a high value placed by the individual on creative work. He needs to have a basic attitude of self-confidence concerning his creative potentialities, a firm conviction concerning the essential worth and validity of his own creative processes and the creative products to which they may lead. Among other things this implies an attitude of independence, a readiness to deviate from, and if necessary to reject, authoritatively pre-established ways of thinking, and an ability to withstand the implicit or explicit pressures of conformity to group opinion.

It seems well established that in order to produce a rich volume of ideas, the individual should be ready to suspend premature criticism of his ideas, to let them emerge before he subjects them. Closely related is a disposition to tolerate a considerable degree of ambiguity, and lack of closure while working at early stages of a creative task, and a disposition to maintain open-mindedness and to avoid premature commitment to a particular solution.

It is plain to see that the skills and attitudes demanded of the creative individual are imposing ones. Moreover, he must have the capacity to maintain a necessary balance between conflicting dispositions -- he must have great ideational fluency, but he must also have the ability for disciplined self-evaluation of his ideas. He must be able to become committed to the particular creative task while still being able to assume detached perspective on it. He must be both intuitive and analytical. He must be able to destroy old forms and to construct new ones.

Thus, above and beyond the specific skills we have alluded to, there is required what we may call a <u>master thinking skill</u> which enables the individual optimally to organize, mobilize, and deploy his specific skills in attack on a

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creative problem. This master thinking skill involved appropriate selecting, timing, balancing, harmonizing, and flexible sequencing in the strategic use of the specific skills. Successful performance in creative problem solving of any complex nature is heavily dependent upon this generalized master thinking skill; the various specific skills--however highly developed each alone may be--will not by themselves suffice for effective creative work. In the following discussion of some essential techniques in programmed instruction for creativity, it will become evident that this crucial master thinking skill merits direct training in and of itself.

ESSENTIAL TECHNIQUES

In most of the conventional applications of programming, the task is to take an already available body of subject matter and to restructure it into programmed form. This is not the situation in programming for creativity. Here there is no already available body of factual material to be programmed; indeed, the task has little to do with assimilation of factual matter, but has mostly to do with the strengthening of skills and the inducing of attitudes of the kinds mentioned above. Thus the challenging task of programming which faces us involves both the working out of appropriate methods and materials for creativity training and the casting of them into an effective programmed instruction form.

Nature of material: Programmed materials for the training of creativity should be so designed as to give the individual repeated practice in making creative responses directly within the context of meaningful creative tasks. For example, a program to train creative problem solving might well consist of a series of actual problems to be solved, problems that involve insight, hypothesis-formation, complex transformation, searching, evaluation, and discovery. The student thinks and works through each problem and is helped to solve it under the careful step-by-step guidance of the program. In this manner the student practices and is gradually strengthened in the specific skills previously discussed, e.g., generating many ideas, thinking of uncommon ideas, reformulating the problem, using subtle cues to discover solutions, etc.

As mentioned previously concerning the master thinking skill, the creative act requires a complex integration and coordination of such part-function skills.

Thus we would stress the value of practicing these specific skills not singly and separately, but within the global context of whole and relatively complex problems. This instructional strategy in which specific skills and the master thinking skill are simultaneously practiced, maximizes the likelihood of transfer of the training to real creative problems which the person will later encounter. This transfer can be further increased by providing wide diversity in the concrete contents of the problems and materials included in the program, for these creative skills are not narrowly relevant to particular subject matter only, but are highly generalized skills transcending subject matter boundaries.

The further advantage of this "creative acts-in-miniature" approach to programming lies in its power to strengthen creative attitudes and dispositions. By undertaking a series of meaningful creative tasks, complex but of manageable proportions, and being guided step by step through the program to a final successful solution of each problem or completion of each task, the individual's self-confidence in his own creative powers is reinforced. He comes to develop a greater feeling of assurance in coping with complex information, despite its initial ambiguity and lack of closure. He comes to understand and to trust an intuitive approach to phenomena, which complements the analytical approach to data. He becomes more familiar with the inescapability of creative activity. For example, he can thus build up greater readiness to persist in creative work in the face of recurrent blacks in ideas and other difficulties in thinking, a readiness not so easily taught by practicing specific skills in isolation.

Sequencing of materials. In the early phases of programming for creativity, the practice problems or tasks should be kept relatively simple. They should be accompanied by a detailed step-by-step tutoring of the individual as to the nature, requirements, and strategies of creative thinking. For example, in the early part of a program to teach for originality of thought, material might well be introduced which explains the concept of originality and illustrates how original ideas might differ from common ones; the individual might then be given guided practice in discriminating between original and unoriginal ideas. As the program proceeds, the kind of material should be reduced and the tasks and problems should be gradually more complex and demanding.

Remedial and supplementary materials should be inserted at various needed points in the program so that every individual--regardless of initial level of

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capability--can be brought to progress successfully through the increasingly difficult sequence of creative tasks. Alternative forms and sequences of the programmed materials should also be provided which are designed to accomodate crucial differences in preferred cognitive styles among individuals as they work on creative problems.

Size of step. The size of step in a program to facilitate creativity needs to be set large enough so as to induce an "essential tension" in the individual, to encourage him to exert a genuine creative effort, however modest, in each step. Thus, as compared with usual programs, with their briefer frames and smaller and easier steps, and typical frame in a program for training creativity is likely to contain more complex materials, require more time for reflection, and call for multiform rather than single responses.

The clear technical challenge to the programer is to the programmer is to produce and maintain a sufficient level of "essential tension" step by step, without at the same time running the risk of over-taxing the individual by steps that are too big.

Role of feedback. Perhaps the most difficult methodological problem in programming for creativity is how to provide appropriate feedback, or confirmation of response. In most usual programming, having to do with the teaching of conventional subject matter, what is to be reinforced is the giving of the one "correct answer," But in creative tasks and problems a greater many different answers are possible and one aim of creativity training is to reinforce this diversity, uniqueness, and individuality of response. Thus a kind of "creative feedback" must be provided that will be relevant and reinforcing for all individuals taking the program regardless of a wide diversity in the particular responses given by them. Suppose, for example, that the student is being trained to think of unusual uses for an object. An effective feedback to his responses might consist of an illustrative set of varied and unusual ideas that could have been produced. The set would be intended to broaden the student's vision as to what constitutes unusual ideas; at the same time it should contain some illustrative ideas not too far removed in quality from the perhaps somewhat more pedestrain ideas that he would have given. In this way his sights may be elevated without unduly discouraging him about his own less impressive initial creative attempts.

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It has been suggested repeatedly that the hallmark of a creative response is its quality of uniqueness coupled with its appropriateness to the particular problem. It is all too easy to instill a set to spew forth verbal associations which are novel and infrequent; but these may be merely bizzare, irrelevant to the demands of the problems at hand. A crucial function of "creative feedback," therefore, is selectively to reinforce those novel responses that are appropriate to the requirements of the problem.

While on the one hand a problem must of necessity give close guidance and direction to the student's thinking, it must not on the other hand be so confining and regimenting as to stifle expressions of uniqueness by the student. Nothing could be more deadly to creative impulse than a method of feedback so rigid and overly-determined as to remove all challenge to the student. Equally would be a method in which the feedback examples are of such consistently superior quality as to discourage the student from thinking of his own ideas because he feels his ideas would be hopelessly inadequate when compared with the standards.

To stimulate unique expression in the student while closely guiding him is always one of the most difficult tasks. In programming creativity, one way of handling this problem might be to use more extensive and complete feedback in the early stages of the program and then gradually reduce the amount of feedback until in the latter stages of the program the student relies almost entirely on his own resources with only occasional reinforcement in the program.

Implicit throughout the program development is the inescapable moral that programmed instruction intended to train creativity must themselves be creative! Imaginativeness, originality, or any other aspect of creative behavior cannot be fostered through a program which is unimaginative, uninventive. The challenge to the creative programmer is clear.

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PART TWO: RESEARCH, PROCEDURE, RESULTS AND FINDINGS

The Problem

The present research to develop programmed instructional materials capable of developing creative behavior in students is the first stage of a contemplated long-range period of research activity designed to ascertain the following: To what extent can programmed instructional materials provide for deliberate development of students' creative behavior and at the same time assure mastery of subject matter?

Creative behavior is herein defined as behavior which demonstrates in its product both uniqueness and value relative either to the individual or his society. The product may be valuable to a group, organization, society, or merely to the individual himself. From a behavioristic viewpoint creative behavior may be considered a response, responses, or pattern of responses which operate upon internal and/or external discriminative stimuli, usually referred to as objects, words or symbols, and result in at least one unique combination that reinforces the response or pattern of responses.

Objectives of the Research

General Objective: The hypothesis tested was that scores on creative ability tests can be significantly increased through a program developed to present incrementally the principles and procedures of a creative problem-solving course. As a by-product, the effect of such a program on student attitudes toward the course was also studied.

Specific Objectives:

(1) To reduce various creative abilities -- fluency, flexibility, originality, elaboration, and sensitivity -- to their manifestations in defining and solving problems creatively. In behavioristic terms, fluency is defined as the ability to generate many responses (ideas) in response to one discriminative stimulus (problem.) Flexibility is defined as the ability to generate many different classes of responses (ideas) in response to one discriminative stimulus (problem.) Originality is defined as the ability to create a response that is statistically uncommon. Elaboration is defined as the ability to generate many responses (details) that implement or spell out an idea which serves as the discriminative stimulus. Sensitivity is defined as the ability to generate many problems or challenges as responses to a situation or observation that serves as

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the discriminative stimulus.

(2) To devise means of immediately reinforcing any response showing any slight tendency towards such creative behavior. Such reinforcement was constructed so that it was not limited to only one correct response. Rather, reinforcement was provided for any response that was considered acceptable and met criterion standards.

(3) To ascertain, by using experimental and control groups in a pre-testing and post-testing design, to what degree this "optimum" program increases the students' creative behavior as measured by various creative ability tests. The purpose of the control groups is to provide a base line for differentiating between improvement due to the treatment effects and that due to general growth and practice effect.

(4) To determine, by the use of experimental and control subjects, whether or not subjects receiving programmed methods alone show increases in creative ability to the same extent as to subjects receiving the same programmed materials by instructor-taught methods, and whether or not either or both of these groups show a significant gain in creative ability when compared with control subjects receiving no training.

(5) To study the attitudes toward the course of students taking the programmed version alone as compared with those receiving the programmed material via an instructor.

Procedure

From the Fall of 1968 to the Fall of 1970 the programmed materials were developed, evaluated and revised. The major experiment was conducted during the Fall of 1971 and the analysis of the results was conducted during the Spring of 1972.

The three groups involved in the experiment included 62 subjects in the "Control" group, 62 subjects in the "Program Alone" group and 62 subjects in the "Program Instructor-Presented" group. To increase the control over the experiment instructors in the "Instructor-Presented" group presented exactly the same material that was given to the "Program Alone" group, only in conventional fashion. These three groups had been randomly selected from 1,086 high school seniors in the Buffalo Public Schools who had asked to be included in the experiment and who planned to continue their formal education after graduation. All were equated on the basis of the Lorge-Thorndike I.Q.

For the purpose of this experiment six schools were used and these schools were designated by a panel of three professional members of the experimental staff as either Type I or Type II schools. Type I schools were those which showed high academic emphasis and a greater interest in education as a whole, including cultural and enrichment opportunities.

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Type II schools were those low on these variables. The panel designated three of the six schools as Type I and three as Type II. One of each "type" was then randomly assigned to each of the three aforementioned groups, with each "type" consisting of 31 students.

Type I schools were very similar to one another and since, in only one statistical test conducted, did there prove to be a consistent effect of school type on treatment means, Type II data are considered, in effect, a replication of Type I data.

While the number of students assigned to each of the three treatment groups numbered 62, as illustrated before, in actuality 335 students were tested. This was done in order to effect a "double check" in the experiment, which consisted of "in the same school" control groups. These checks were in addition to the "Control group" itself and permitted experimental subjects in one school to be compared with control subjects from this same school.

The experiment consisted of a pre-test period of one week, or two full periods, during which time the three groups were given a battery of 11 psychological tests developed by Guilford, Torrance and Gough. The test are:

Test	Reliability of Scoring
1. Associational Fluency	.94
2. Other Uses-Quantity	.99
3. Consequences-Total	.97
4. Product Improvement - Fluency	1.00
5. Product Improvement - Fluency	1.00
6. Alternate Uses	.96
7. Product Improvement - Flexibility	.82
8. Product Improvement- Flexibility	.74
9. Consequences - Remote	.68
10. Product Improvement - Originality	.78
11. Product Improvement - Originality	.81
12. Planning Elaboration - Part A	.88
13. Planning Elaboration - Part B	.99
14. Apparatus - Items 1-9	.80
15. Apparatus - Items 10-18	.78
16. AC Test of creative ability	
17. California Psychological Inventory	

The treatment period lasted 13 weeks, each experimental week consisting of two periods. The post-testing period also lasted one week, or two full periods, and the same 17 psychological post-tests were administered to the three groups. All of the measures were then scored by two independent raters. Identification of the protocols and coded so that no rater was aware of what type of subject or school he was rating.

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Table 4

Average Post-test Means Adjusted for Pre-test Differences (by Covariance)

Test	Type I Schools					Type II Schools				
	Prog.-Alone	Prog.-School Control	With-Inst.	Inst.-School Control	Control School	Prog.-Alone	Prog.-School Control	With-Inst.	Inst.-School Control	Control School
Assoc. Fluency	16.0	12.7	13.3	13.7	14.1	16.3	16.1	16.1	13.0	12.2
Other Uses	12.7	9.4	13.2	8.8	11.3	13.3	9.2	17.3	9.2	11.1
Conseq. Total	17.8	15.6	19.0	14.6	16.1	18.0	18.1	20.9	15.9	15.3
P.I. Fluency	14.6	11.4	17.0	11.9	12.4	14.6	12.8	17.8	12.6	13.6
Alt. Uses	18.9	18.0	19.0	15.9	15.9	20.3	16.6	19.1	16.0	15.7
P.I. Flexibility	7.5	5.9	8.5	6.0	6.9	7.9	6.7	8.7	6.9	6.1
Conseq. Remote	7.2	7.1	8.1	5.7	6.3	7.6	6.5	8.6	7.1	7.1
P.I. Originality	4.8	1.7	4.6	3.0	3.9	4.9	2.3	6.4	4.0	3.1
Planning Elab.	12.8	10.2	14.0	10.2	11.8	13.0	10.8	14.2	11.1	10.6
Apparatus	8.2	7.8	8.5	8.0	7.2	8.4	7.1	8.7	8.3	7.2
C.P.I. Dominance	28.2	27.9	27.7	27.0	26.9	28.1	26.8	27.1	26.2	26.7

Note: Means for Prog.-School Control and Inst.-School Control are from Runs B and C, respectively. The other means are means of adjusted means from Runs A and B (Prog.-Alone), A and C (With-Inst.), or A, B, and C (Control School). Cell frequencies for analyses of covariance same as for analyses of variance of pre-test scores.

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Findings

To briefly summarize the findings, it can be stated that the experimental groups, on almost every test, made greater gains than did the control group. In almost all of the measures the gains of the instructor-taught programmed groups were significantly superior to those of the control groups. The program alone group was significantly superior to the control group in gains on most tests, but the instructor-taught programmed group tended to be more markedly and consistently superior to the control group than the program alone group who had the program without an instructor.

The largest effects of the training were on Flexibility and Elaboration, while effects on Fluency and Originality were less. Sensitivity showed the least effects. The questionnaire revealed that almost half of the students reported that they gain in sensitivity at the high end of the scale. Further study is indicated on this factor.

Detailed Statistical Analyses of Data

The pre-test data were analyzed in order to ascertain whether the School Types differed initially, whether the schools within each Type differed initially, and whether the groups within each Experimental school differed initially. (It might be noted that the third kind of difference would represent sampling error, since the subjects were assigned to the Experimental and In-The-Same-School Control groups in a random manner.) The logic of the experiment required the use of three separate analyses, each with a two-by-three factorial design. In each analysis the factors were School Types, with two levels, and Groups, with three levels. In "Run A" the Program-Alone, With-Instructor, and Control School groups were compared; in "Run B" the Program-Alone, Program-School Control, and Control School groups were compared; and in "Run C" the With-Instructor, Instructor-School Control, and Control-School groups were compared. (The Program School Control groups were in the same schools as the Program-Alone groups; and the Instructor-School control groups were in the same schools as the With-Instructor groups.) School Types I and II were represented in all three analyses. Each "run" tested differences between School Types and Differences among schools within Types. Runs B and C also tested differences between groups within schools (e.g., Program-Alone group versus Program-School Control group.)

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Table 1 gives the cell frequencies (group sizes) for the analyses of variance and covariance, and shows how 31 subjects were obtained in each of the major groups. The analysis of variance and covariance require equal numbers of subjects in corresponding groups in the two School Types. The numbers of available subjects were examined, and the numbers to be omitted were determined in such a way that the numbers retained were maximized within the imposed restriction. Insofar as possible, subjects to be omitted were selected on the basis of some kind of "contamination," such as having an excessive number of absences from school, having an Otis IQ score instead of a Lorge-Thorndike IQ score, or having taken the tests in an unusual way -- for example, because of being absent on the scheduled testing day. (In no cases were test data examined in making the selection.) When necessary, additional subjects were omitted by selection from a table of random numbers.

Table 2 (page 18) presents the mean pre-test scores of the various groups, and Table 3 (page 19) summarizes the analyses of variance of the pre-test data. As can be seen in Table 3, the School Types by Groups interaction was statistically significant in almost every "run." The interactions indicate that there were differences among schools within each School Type, and that the directions of difference were not the same in both School Types. The differences were fairly large, as can be seen by inspection of Table 2.

Because the magnitudes of the differences among the groups on the pre-tests were fairly large, the post-test data were analyzed by means of analysis of covariance techniques. Three runs were used, with the same comparisons as in the three pre-test runs. The means of the adjusted post-test scores are presented in Table 4 (page 20). (The means of the raw post-test scores and the means of the adjusted post-test scores from each separate run are given in Tables 7 and 8.) In general, the With-Instructor groups had higher adjusted post-test means than the Program-Alone groups and both control groups (i.e., the Instructor-School Control and Control School groups.) With somewhat less consistency, the Program-Alone groups were superior to the corresponding control groups (i.e., The Program-School Control and Control School groups.)

The results of the analyses of covariance are summaried in Table 5. The Run A analyses, comparing the Program-Alone, with -instructor, and Control-School groups, indicated that the main effect of Groups was significant on every test

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Table 1

Sample Sizes for Analyses of Variance and Covariance

Sample Size	Type I Schools					Type II Schools				
	Prog. - Alone	Prog. - School Control	With-Inst.	Inst. - School Control	Control School	Prog. - Alone	Prog. - School Control	With-Inst.	Inst. - School Control	Control School
All tests except Other Uses	31	10	31[a]	12	31	31	10	31	12	31
Other Uses	31	10	17	12	27[b]	31	10	17[b]	12[b]	27
Number of Omitted Subjects										
All tests except Other Uses	0	1	a	0	1	0	0	2	12	0
Other Uses	0	1	13	0	0	0	0	0	0	4

[a] Includes one fictitious subject (group means). (See Lindquist, 1956, p. 148.)
[b] Data lost because of expiration of available testing time (Other Uses was last test in battery).

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Table 2

Pre-test Means

Test	Type I Schools					Type II Schools				
	Prog. - Alone	Prog. - School Control	With-Inst.	Inst. - School Control	Control School	Prog. - Alone	Prog. - School Control	With-Inst.	Inst. - School Control	Control School
Assoc. Fluency	12.1	13.0	11.6	10.9	13.4	14.0	15.0	13.4	13.5	11.8
Other Uses	8.0	8.1	7.6	6.2	9.3	9.0	10.4	9.9	7.8	8.5
Conseq. Total	15.6	16.3	13.0	15.4	15.8	16.5	15.7	17.4	14.6	13.6
P.I. Fluency	11.3	11.7	10.6	11.3	12.9	13.6	11.2	13.6	12.8	10.1
Alt. Uses	13.4	15.0	14.4	14.6	15.7	17.0	16.8	16.3	14.1	14.3
P.I. Flexibility	6.6	5.9	5.8	6.8	6.7	6.6	6.6	7.0	6.5	5.8
Conseq. Remote	5.7	4.3	5.0	5.6	6.3	6.6	5.7	7.2	6.9	4.3
P.I. Originality	9.3	10.6	8.4	9.2	10.8	11.9	10.1	11.5	10.3	8.2
Planning Elab.	10.2	11.0	8.9	9.8	10.5	10.4	10.8	11.7	12.7	9.9
Apparatus	6.4	7.3	6.9	5.7	7.4	7.1	5.9	8.6	7.2	5.7
C.P.I. Dominance	27.4	25.2	26.9	22.0	24.1	26.9	27.6	27.6	28.9	26.2
IQ	116.4	114.8	113.6	114.8	116.7	118.2	120.6	118.8	117.2	117.1

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Table 3

Pre-test -- Results of Analyses of Variance

Source of Variance	df	Test: Assoc. Flu.	Other Uses	Conseq. Total	P.I. Flu.	Alt. Uses	P.I. Flex.	Conseq. Remote	P.I. Orig.	Plan. Elab.	App.	C.P.I. Dom.	I
Run A													
Schools (S)	1	1.32	2.10	2.01	2.03	3.75	<1.00	<1.00	2.44	2.87	<1.00	<1.00	5.3
Groups (G)	2	<1.00	<1.00	1.20	<1.00	<1.00	<1.00	1.47	<1.00	<1.00	4.83***	2.19	<1.
S x G	2	3.40*	1.82	6.96***	10.34***	4.58**	6.37***	6.75***	7.99***	4.79***	8.97***	<1.00	1.
within cells	-	17.27 (179)	10.30 (144)	24.63 (179)	14.90 (179)	22.41 (179)	2.45 (179)	10.35 (179)	18.85 (179)	10.25 (179)	5.26 (179)	40.34 (179)	53. (17
Run B													
Schools	1	<1.00	1.31	<1.00	<1.00	2.08	<1.00	<1.00	<1.00	<1.00	2.53	<1.00	2.
Groups	2	<1.00	<1.00	1.11	1.03	<1.00	<1.00	1.54	1.14	<1.00	<1.00	1.41	<1.
S x G	2	2.94	1.52	1.29	6.71***	4.17**	2.43	3.61*	6.32***	<1.00	4.40**	<1.00	1.
within cells	-	17.61 (138)	9.93 (130)	29.33 (138)	14.63 (138)	24.12 (138)	2.28 (138)	10.77 (138)	16.62 (138)	10.70 (138)	5.55 (138)	41.33 (138)	47. (13
Run C													
Schools	1	<1.00	1.96	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	6.43**	<1.00	5.04*	5.
Groups	2	<1.00	4.06**	<1.00	<1.00	<1.00	<1.00	1.41	<1.00	<1.00	5.30***	2.03	<1.
S x G	2	3.50*	2.12	7.53***	8.91***	1.93	6.53***	7.30***	7.22***	4.63**	9.87***	2.29	1.
within cells	-	16.77 (141)	9.64 (106)	23.96 (141)	15.23 (141)	22.78 (141)	2.47 (141)	9.71 (141)	16.93 (141)	11.36 (141)	5.16 (141)	37.36 (141)	51. (14

Note: The "within cells" rows give mean squares and in parenthesis df.

* $p < .05$
** $p < .025$
*** $p < .01$

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Table 6

Comparisons of Adjusted Post-test Means (from Analyses of Covariance):
I. Comparisons of Groups in Combined School Types

Groups Compared	Run	Test: Conseq. Total	P.I. Flu.	Alt. Uses	P.I. Flex.	Conseq. Remote	P.I. Orig.	Plan. Elab.	App.
With-Inst. vs. Prog.-Alone	A	3.01**	3.04**	<1.00	2.74**	1.53	1.29	2.05*	<1.00
With-Inst. vs. Control School	A	5.96**	5.64**	4.24**	6.74**	2.71**	3.67**	4.98**	2.58*
With-Inst. vs. Control School	C	6.08**	5.73**	4.56**	6.97**	2.82**	3.91**	4.93**	2.75**
With-Inst. vs. Inst.-School Control	C	4.80**	4.97**	3.17**	5.32**	2.40*	2.91**	4.35**	<1.00
Inst.-School Control vs. Control School	C	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.39
Prog.-Alone vs. Control School	A	2.90**	2.08*	4.86**	3.99**	1.19	2.39*	2.93**	2.30*
Prog.-Alone vs. Control School	B	2.95**	2.06*	4.90**	4.05**	a	2.59*	3.16**	2.50*
Prog.-Alone vs. Prog.-School Control	B	1.10	2.23*	2.04*	3.33**	a	3.91**	3.04**	1.20
Prog.-School Control vs. Control School	B	<1.00	<1.00	1.38	<1.00	a	-2.08*	<1.00	<1.00

Note: For each test included in this table, analysis of covariance showed a significant Group effect and a nonsignificant Schools by Groups interaction (except as indicated by Note a). The body of the table gives values of t computed with denominator based on within-cells variances of indicated run (Lindquist, 1956, p. 327). The df of t is the same as the df of the within-cells variance of the indicated run.

a. F's for Groups and interaction in analysis of covariance not significant.

* $p < .05$

** $p < .01$

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Table 7

Comparisons of Adjusted Post-test Means (from Analyses of Covariance):
II. Comparisons of Groups in Separate School Types

Groups Compared	Run	Assoc. Fluency		Other Uses	
		Type I Schools	Type II Schools	Type I Schools	Type II Schools
With-Inst. vs. Prog.-Alone	A	-2.57*	<1.00	2.58**[a]	
With-Inst. vs. Control School	A	<1.00	4.05**	4.70**[a]	
With-Inst. vs. Control School	C	<1.00	4.40**	3.12**	6.02**
With-Inst. vs. Inst.-School Control	C	<1.00	2.43*	1.58	5.78**
Inst.-School Control vs. Control School	C	<1.00	<1.00	-1.91	-1.44
Prog.-Alone vs. Control School	A	1.79	4.17**	2.34*[a]	
Prog.-Alone vs. Control School	B	1.83	4.02**	2.48*[a]	
Prog.-Alone vs. Prog.-School Control	B	2.35*	<1.00	3.65**[a]	
Prog.-School Control vs. Control School	B	-1.09	2.56*	-1.83[a]	

Note: For both tests included in this table, analysis of covariance showed a significant Schools by Groups interaction (except as indicated by Note a). The body of the table gives values of t computed with denominator based on within-cells variances of indicated run (Lindquist, 1956, p. 327). The df of t is the same as the df of the within-cells variance of the indicated run.

a. F for interaction nonsignificant, F for Groups significant.

* $p < .05$

** $p < .01$

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of creativity but was not significant on the personality test (C.P.I. Dominance.) The School Types by Groups interaction was not significant except in the three runs on Associational Fluency and in Run C on Other Uses.

Tables 6 and 7 summarize the results of t tests comparing individual groups, and Table 8 summarizes the interpretations of the outcomes of these tests. In Tables 6 and 7, a negative value of t means that the second group listed in the row had a greater mean than the first group, and a positive value means that the first group had the greater mean. Table 6 summarizes comparisons of the separate groups in each run in which the main effect of Groups was significant and the School Types by Groups interaction was non-significant. These comparisons showed that the Instructor-School Control groups were not significantly different from the Control School groups in any of these runs; and the Program-School Control was significantly different from the Control School group only in Run B on Product Improvement Originality. The With-Instructor group was significantly superior to the Control School group on all ability tests. The With-Instructor group was also superior to the Instructor-School Control group on all of these tests, significantly so on all but the Apparatus test. The Program-Alone group was superior to the Control School group on all ability tests, and the difference was significant on all tests except Consequences Remote. The Program-Alone group was also superior to the Program-School Control group on all ability tests, significantly so on all except Apparatus, Consequences Remote, and Consequences Total. The With-Instructor group was significantly superior to the Program-Alone group on Planning Elaborations, Consequences Total, and Product Improvement Fluency and Flexibility, but was not significantly different from the Program-Alone group on Alternate Uses, Apparatus, Product Improvement Originality, and Consequences Remote.

On the two tests on which there was a significant School Types by Groups interaction, the groups were compared separately within each School Type. These comparisons are summarized in Table 7. In general, differences were more often significant in the Type II schools than in the Type I schools. In the Type I schools on Associational Fluency, the Program-Alone group was significantly superior to the With-Instructor group and the Program-School Control group, and was superior to the Control School group at the .10 level of significance. No other differences approached significance. In the Type II schools on Associational Fluency, the pattern of results was essentially the same as for

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the tests on which the interaction was not significant, except that the Program-Alone group was not significantly different from the Program-School Control group, which in turn was significantly superior to the Control School group.

On other uses, the interaction was significant only in Run C, and as shown in Table 7, there was no discrepancy between the comparison of the With-Instructor and Control School groups based on Run A and the comparisons of these groups based on Run C. The interaction in Run C apparently resulted primarily from a difference between the School Types in the comparison of the With-Instructor and Instructor-School Control groups. The difference between these groups was significant only in the Type II schools.

In summary, the pattern of results on the various tests of creative ability permits the generalization that the With-Instructor groups were superior to the Program-Alone groups and to both Control groups; and the Program-Alone groups were superior to both Control groups. The tests most representative of this outcome were Planning Elaboration, Product Improvement Fluency, and Product Improvement Flexibility; and Alternate Uses, Other Uses, Product Improvement Originality, and Consequences Total gave essentially the same pattern of results. Associational Fluency yielded different results in the two School Types. On this test the experimental treatments were more effective in the Type II schools than in the Type I schools. The Consequences Remote test showed results that were partly consistent with the generally obtained pattern, since the With-Instructor group was significantly superior to the Control groups on this test. On the Apparatus test, the Experimental groups were not significantly different from each other, nor from their respective In-The-Same-School Controls, but each was significantly superior to the Control School group.

Analysis of Student Reactions

Regarding students' own reactions to the course instructor as compared with those who had an instructor-taught programmed course, it is interesting to note that, even though the instructor-taught students found the course more interesting and felt they gained more from it, both groups, in their total comments, appeared to report equal application of what they had learned and seemed to feel they would apply it equally well in the future.